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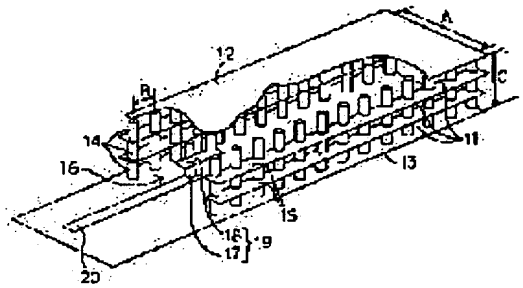
(54) CONNECTION STRUCTURE BETWEEN DIELECTRIC WAVEGUIDE LINE AND HIGH FREQUENCY LINE CONDUCTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a connection structure between a dielectric waveguide line and a high frequency line conductor that can connect the laminated dielectric waveguide line with the high frequency line conductor such as a microstrip line, a strip line or a high frequency line with an excellent characteristic even when a characteristic impedance of the dielectric waveguide line differs from that of the high frequency line conductor.
SOLUTION: The connection structure is used to connect a high frequency line conductor 20 with a dielectric waveguide line 16 by inserting an end of the high frequency line conductor 20 to an opening end of the dielectric waveguide line 16 consisting of a couple of main conductor layers 12, 13 having a dielectric board 11 inbetween and two rows of through-conductor groups 14 for sidewall that are formed between the main conductor layers 12, 13 at a prescribed interval with a prescribed width and of a sub conductor layer 15 and by electrically connecting the end of the high frequency line conductor 20 and one (12) of the main conductor layers 12, 13 with a connection use line conductor 18 and a connection use through-conductor 17 in a way of forming a step. Even when the characteristic impedance of the conductor 20 differs from that of the line 16, the connection structure connects the both with an excellent characteristic and since the thickness of the connection structure is thin, the connection structure can be miniaturized.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] In the initiative body whorl of the pair which pinches a dielectric substrate from the upper and lower sides, and the transmission direction of a RF signal, at intervals of less than 1/2 repeat of signal wave length and the penetration for side attachment walls of two trains which connected between said initiative body whorls in said transmission direction and the direction which intersects perpendicularly electrically, and were formed in it by predetermined width of face -- a conductor -- with a group Provide the subconductor layer electrically connected with the group, and it changes. it forms in an initiative body whorl and parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- said initiative body whorl and the penetration for side attachment walls -- a conductor, while inserting the edge of the line conductor for RFs which transmits said RF signal to the opening edge of the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group and the subconductor layer The line conductor for connection arranged in parallel in the same transmission direction as said line conductor for RFs in the edge of this line conductor for RFs, and one side of said initiative body whorl, the penetration for connection arranged in the edge of this line conductor for connection by intersecting perpendicularly -- the connection structure of the dielectric-waveguide track and the line conductor for RFs which are characterized by connecting electrically so that the shape of a stairway may be accomplished with a conductor.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the connection structure of the dielectric-waveguide track and the line conductor for RFs which can connect the dielectric-waveguide track which is the transmission line which transmits RF signals, such as a microwave band and a millimeter wave band, and line conductors for RFs, such as a microstrip line, by low loss.
[0002]
[Description of the Prior Art] In recent years, research of the mobile communications using RF signals, such as a microwave band and a millimeter wave band, the radar between vehicles, etc. is advanced briskly. As the transmission line for RFs for transmitting a RF signal in these RF circuits, line conductors for RFs, such as a coaxial track, a waveguide, a dielectric-waveguide track and a microstrip line, and the strip line, etc. are known conventionally.
[0003] Recently, since two or more arrangement of the RF track where classes differ is carried out into the wiring circuit which constitutes a RF circuit, the connection technique between these RFs tracks has become important, and various structures are proposed about the connection structure.
[0004] For example, with the connection structure of a waveguide or a dielectric waveguide, and a coaxial track, it connects by inserting the signal line of a coaxial track into a waveguide, and joining together in RF.
[0005] Moreover, with the connection structure of a waveguide and a microstrip line, when making a waveguide and a microstrip line intersect perpendicularly and connecting, the structure which inserts into a waveguide the dielectric substrate with which the microstrip line was formed is used. Moreover, when connecting a waveguide and a microstrip line in an parallel direction, the structure inserted in the interior of the so-called ridge waveguide which narrowed the line conductor of a microstrip line the shape of a curve toward the edge which connects is known.
[0006]
[Problem(s) to be Solved by the Invention] It continues till recently, and if a RF track is formed on the substrate with which a RF circuit is constituted, or in a substrate, since it will become advantageous in respect of a miniaturization, to form a dielectric-waveguide track with a laminating technique in the wiring substrate of multilayer structure is desired. For example, in JP,6-53711,A, a dielectric substrate is pinched by the initiative body whorl of a pair, and the waveguide track which formed the side attachment wall by the beer hall group arranged by two trains which connect between conductor layers further is proposed. the false conductor according [this waveguide track] the four way type of dielectric materials to the initiative body whorl and beer hall group of a pair -- surrounding with a wall -- a conductor -- Kabeuchi's field is made into the track for signal transmissions.
[0007] When mainly using the dielectric-waveguide track of the laminating mold arranged in the interior of such a multilayer-interconnection substrate as the transmission line of the ceramic multilayer-interconnection substrate for microwave and millimeter waves, or the semiconductor package for high frequency, connection with other high frequency circuits is needed.
[0008] On the other hand, the connection structure using electromagnetic association by the slot hole prepared in the initiative body whorl of a dielectric-waveguide track as shows an outline configuration to drawing 4 with a perspective view as connection structure of the dielectric-waveguide track of a laminating mold and a microstrip line is proposed.
[0009] As opposed to the dielectric-waveguide track 5 of the above-mentioned laminating mold which consists of side attachment walls 4 formed of the group penetration of the beer hall group arranged by two trains which according to drawing 4 whose dielectric substrates 1 are pinched by the initiative body whorl 2-

3 of a pair, and connect between the initiative body whorls 2-3 further -- a conductor -- The slot hole 6 for electromagnetic couplings is formed in the initiative body whorl 2 of one of these, and by this, the line conductor 8 of a RF track and the dielectric-waveguide tracks 5, such as a microstrip line formed on the multilayer-interconnection substrate 7 grade, are combined electromagnetic, and it connects.
[0010] According to this connection structure, an electromagnetic coupling can be easily carried out to other line conductors for RFs by forming the slot hole 6 in a part of initiative body whorl 2. And the multilayer-interconnection substrate 7 and the dielectric-waveguide track 5 in which the line conductor 8 for RFs which has this connection structure was formed can all apply the conventional ceramic laminating technique, and can produce it easily.
[0011] However, with the connection structure of the dielectric-waveguide track 5 of such a laminating mold, and the line conductor 8 for RFs, since the laminating of the multilayer-interconnection substrate 7 with which the line conductor 8 for RFs was formed in the upper part of the dielectric-waveguide track 5 was carried out, the thickness of the whole connection will increase and there was a trouble that it was difficult to miniaturize the whole connection structure.
[0012] And since the characteristic impedance of the dielectric-waveguide track 5 and the line conductor 8 for RFs connected to the dielectric-waveguide track 5 through the slot hole 6 generally was not in agreement, in the connection, reflection of the RF signal by the inequality of a characteristic impedance occurred, and it had the trouble that a transparency property would also deteriorate in coincidence.
[0013] This invention is thought out in view of the trouble of the above-mentioned conventional technique, and the purpose is in offering the connection structure of the dielectric-waveguide track and the line conductor for RFs which can connect line conductors for RFs, such as a dielectric-waveguide track of a laminating mold, and other microstrip lines, the strip line, a RF track, in a good property even if both characteristic impedances differ.
[0014]
[Means for Solving the Problem] In the structure of connecting a dielectric-waveguide track and the line conductor for RFs as a result of this invention's repeating examination to the above-mentioned trouble the line conductor for RFs -- the edge of a dielectric-waveguide track -- inserting -- the penetration for connection from the insertion section -- with the structure where the thickness of a connection is thin, by connecting the edge of the line conductor for RFs to the initiative body whorl of a dielectric-waveguide track electrically with a conductor and the line conductor for connection, as the shape of a stairway is accomplished And it found out that the outstanding transparency property was acquired.
[0015] The connection structure of the dielectric-waveguide track of this invention, and the line conductor for RFs In the initiative body whorl of the pair which pinches a dielectric substrate from the upper and lower sides, and the transmission direction of a RF signal, at intervals of less than 1/2 repeat of signal wave length and the penetration for side attachment walls of two trains which connected between said initiative body whorls in said transmission direction and the direction which intersects perpendicularly electrically, and were formed in it by predetermined width of face -- a conductor -- with a group Provide the subconductor layer electrically connected with the group, and it changes. it forms in an initiative body whorl and parallel between said initiative body whorls -- having -- said penetration for side attachment walls -- a conductor -- said initiative body whorl and the penetration for side attachment walls -- a conductor, while inserting the edge of the line conductor for RFs which transmits said RF signal to the opening edge of the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group and the subconductor layer The line conductor for connection arranged in parallel in the same transmission direction as said line conductor for RFs in the edge of this line conductor for RFs, and one side of said initiative body whorl, the penetration for connection arranged in the edge of this line conductor for connection by intersecting perpendicularly -- it is characterized by connecting electrically so that the shape of a stairway may be accomplished with a conductor.
[0016]
[Embodiment of the Invention] Hereafter, it explains, referring to a drawing about the connection structure of the dielectric-waveguide track of this invention, and the line conductor for RFs.
[0017] Drawing 1 is the partial fracture perspective view showing an example of the gestalt of operation of the connection structure of the dielectric-waveguide track of this invention, and the line conductor for RFs.
[0018] the penetration for side attachment walls of two trains in which the initiative body whorl of the pair to which 11 pinches a dielectric substrate and 12 and 13 pinch the dielectric substrate 11 from the upper and lower sides, and 14 were less than 1/2 repeat spacing of signal wave length, and they were formed in it by predetermined width of face in drawing 1 in the direction of a signal transmission, and the direction which

intersects perpendicularly as they connected between the initiative body whorls 12.13 of a pair in the direction of a signal transmission electrically -- a conductor -- it is a group. 15 [moreover,] -- the penetration for side attachment walls -- a conductor -- the penetration which forms each train of a group 14 -- a conductor -- it is the subconductor layer which connects comrades electrically and which was formed in parallel with the initiative body whorl 12-13. these initiative body whorl 12-13 and the penetration for side attachment walls -- a conductor -- the field surrounded by the group 14 and the subconductor layer 15 constitutes the dielectric-waveguide track 16 which transmits a RF signal.

[0019] On the other hand, 20 is line conductors for RFs, such as a microstrip line, and the strip line, a RF track, is formed the dielectric substrate top which is not illustrated and in a multilayer-interconnection substrate, and is connected with the dielectric-waveguide track 16. The dielectric substrate, multilayer-interconnection substrate, etc. may make the part share with some dielectric substrates 11 of the dielectric-waveguide track 16.

[0020] A conductor and 18 are the line conductors for connection, and the line conductor 18 for connection is arranged in parallel in the same transmission direction as the line conductor 20 for RFs. 17 [and] -- the penetration for connection -- The shape of a stairway is accomplished with a conductor 17 and the line conductor 18 for connection. the penetration for connection -- a conductor 17 intersects perpendicularly and is arranged in the edge of the line conductor 18 for connection -- having -- **** -- the penetration for these connection -- The edge of the line conductor 20 for RFs inserted in the opening edge of the dielectric-waveguide track 16 and one initiative body whorl 12 of the dielectric-waveguide track 16 are connected electrically.

[0021] moreover, the penetration for connection of this connection part -- the stair-like converter 19 consists of a conductor 17 and a line conductor 18 for connection. Since a converter 19 functions as an impedance converter which performs both characteristic-impedance adjustment when this will constitute the so-called ridge waveguide which narrowed spacing between the up-and-down initiative body whorls 12.13 in the dielectric-waveguide track 16 of a connection stair-like and the characteristic impedances of the dielectric-waveguide track 16 and the line conductor 20 for RFs differ, the reflection loss of the RF signal in a connection is reduced, and it becomes the connection structure of a good transparency property.

[0022] namely, the edge of the line conductor 20 for RFs which the edge of the line conductor 20 for RFs is inserted in the interior from the opening edge of the dielectric-waveguide track 16, and was inserted -- the penetration for connection -- it works as a ridge waveguide with the stair-like transducer 19 constituted by the conductor 17 and the line conductor 18 for connection, and the operation which reduces reflection of a RF signal is made. the thickness of the dielectric substrate with which the characteristic-impedance adjustment for connecting the dielectric-waveguide track 16 and the line conductor 20 for RFs with which characteristic impedances differ using such a converter 19 in the condition of low reflection constitutes a converter 19, and the penetration for connection -- it can adjust by the die length of a conductor 17 and the line conductor 18 for connection etc.

[0023] Although the dielectric-waveguide track 16 is constituted as a thing of a three-tiered structure and the line conductor 18 for connection is formed with the line conductor of one layer in the dielectric substrate 11 in the example of drawing 1 , it is also possible by considering the dielectric substrate 11 as a multilayer configuration more to increase the number of stages of a transducer 19 with two step, three step, four step, and five step --. Thus, if the number of stages of a transducer 19 is increased, matching of an impedance can be taken more effectively.

[0024] moreover, the penetration for connection -- since the leakage of a conductor 17 of an electromagnetic wave will be lost if the spacing is made smaller than 1/2 of signal wave length -- the penetration for connection -- a conductor -- as for spacing of 17 comrades, it is desirable that it is less than [of signal wave length] 1/2. the penetration for connection -- although the conductor 17 was arranged in one train in the example of drawing 1 , they may be two or more trains. Moreover, you may arrange in the shape of [so-called] alternate.

[0025] In addition, in drawing 1 , on account of a display, although the dielectric substrate 11 is omitted and being illustrated, such structures are usually formed into the dielectric substrate 11. Moreover, a part of initiative body whorl 12 is fractured and shown so that the structure inside the dielectric-waveguide track 16 may be known.

[0026] As shown in drawing 1 , the initiative body whorl 12-13 of a pair is formed in the location which pinches the dielectric substrate 11 of predetermined thickness C, and the initiative body whorl 12-13 is formed in the vertical side of the dielectric substrate 11 which faces across a transmission-line formation location at least. moreover, the through hole which connects the initiative body whorls 12 and 13 electrically

between the initiative body whorls 12.13 -- a conductor and beer -- penetration of a conductor etc. -- many conductors prepare -- having -- penetration of these large number -- a conductor -- the penetration for side attachment walls of two trains -- a conductor -- the group 14 is formed.
[0027] the penetration for side attachment walls of two trains -- a conductor -- in the transmission direction, i.e., track formation direction, of a RF signal, a group 14 is less than (desirably below a quadrant) 1/2 predetermined repeat spacing (pitch) B of signal wave length, and is formed in the transmission direction and the direction which intersects perpendicularly with the predetermined spacing (width of face) A. This forms the electric side attachment wall in this dielectric-waveguide track 16.
[0028] the case where it uses by the single mode although there is especially no limit to the spacing C between the thickness 12.13 of the dielectric substrate 11, i.e., the initiative body whorl of a pair, here -- the penetration for side attachment walls -- a conductor -- it is good to consider as about 1/2 and about 2 times to the width of face A of a group 14. the part to which the part which hits the H plane of a dielectric waveguide 16 in the example of drawing 1 is equivalent to the Eth page in the initiative body whorl 12-13 -- the penetration for side attachment walls -- a conductor -- it is formed by the group 14 and the subconductor layer 15, respectively. moreover, the penetration for side attachment walls -- a conductor -- the part to which the part which is equivalent to the Eth page of about 2 times, then the dielectric-waveguide track 16 about the thickness of the dielectric substrate 11 to the width of face B of a group 14 hits an H plane in the initiative body whorl 12-13 -- the penetration for side attachment walls -- a conductor -- it will be formed by the group 14 and the subconductor layer 15, respectively.
[0029] moreover, penetration -- the repeat spacing B of a conductor is set as less than 1/2 spacing of signal wave length -- the penetration for side attachment walls -- a conductor -- an electric wall can be formed by the group 14. This spacing B is below the quadrant of signal wave length desirably.
[0030] Since a TEM wave can be spread between the initiative body whorls 12.13 of the pair arranged in parallel, the penetration for side attachment walls -- a conductor -- the penetration in each train of a group 14, since the clearance will act as a slot and an electromagnetic wave will leak, if the repeat spacing B of a conductor is larger than 1 (lambda/2)/2 of the signal wave length lambda even if it supplies electric power to this dielectric-waveguide track 16 in an electromagnetic wave -- an electromagnetic wave -- the penetration for side attachment walls -- a conductor -- it leaks from between groups 14 and does not spread along the false waveguide track made here. However, if the spacing B is smaller than lambda/2, an electric side attachment wall will be formed, and an electromagnetic wave cannot be perpendicularly spread to the dielectric-waveguide track 16, but it will be spread in the direction of a signal transmission of the dielectric-waveguide track 16, reflecting. consequently -- according to a configuration like drawing 1 -- the penetration for side attachment walls of the initiative body whorl 12-13 of a pair, and two trains -- a conductor -- the field of the size of AxC serves as [the cross section surrounded by a group 14 and the subconductor layer 16] the dielectric-waveguide track 16.
[0031] in addition -- the example shown in drawing 1 -- the penetration for side attachment walls -- a conductor -- although the group 14 was formed in two trains -- this penetration for side attachment walls -- a conductor -- a group 14 -- four trains or six trains -- arranging -- the penetration for side attachment walls -- a conductor -- the false conductor by the group 14 -- forming a wall in three-fold [a duplex and] -- a conductor -- the leakage of the electromagnetic wave from a wall can also be prevented more effectively.
[0032] Since it becomes the transmission line by the dielectric waveguide according to such a dielectric-waveguide track 16, it is epsilonr about the specific inductive capacity of the dielectric substrate 11. If it carries out, the waveguide size is 1/rootepsilonr of the usual waveguide. It becomes magnitude. Therefore, specific-inductive-capacity epsilonr of the ingredient which constitutes the dielectric substrate 11 Waveguide size can be made small, and the miniaturization of a RF circuit can be attained and it can consider as the dielectric-waveguide track 16 of magnitude available also as the transmission line of the multilayer-interconnection substrate with which wiring is formed in high density, the package for semiconductor device receipt, or the radar between vehicles, so that it considers as a large thing.
[0033] in addition, the penetration for side attachment walls -- a conductor -- the penetration which constitutes a group 14 -- in order to realize a good transmission characteristic, as for this repeat spacing, considering as fixed repeat spacing is desirable [the conductor is arranged as mentioned above at intervals of less than 1/2 repeat of signal wave length, and], but as long as it is less than 1/2 spacing of signal wave length, it may be made to change suitably or some values may be combined.
[0034] Although it does not divide and limit if it has the property which functions as a dielectric and does not bar transmission of a RF signal as a dielectric substrate 11 which constitutes such a dielectric-waveguide track 16, as for the dielectric substrate 11, from the point of the precision at the time of forming the

transmission line, and the ease of manufacture, consisting of the ceramics is desirable.
[0035] Although the ceramics with specific inductive capacity various until now as such ceramics is known, in order to transmit a RF signal on the dielectric-waveguide track concerning this invention, it is desirable that they are paraelectrics. Generally this is because as for the ferroelectric ceramics dielectric loss becomes and transmission loss becomes large in a RF field. Therefore, specific-inductive-capacity epsilonr of the dielectric substrate 11 4-100 Extent is suitable.
[0036] Moreover, for the line breadth of the wiring layer generally formed in a multilayer-interconnection substrate, or the package for semiconductor device receipt or the radar between vehicles, specific inductive capacity since it be about 1mm at the maximum be 100. When it use so that the upper part may become the electromagnetic-field distribution which an H plane, i.e., a field, roll in parallel with an upper field using an ingredient, the minimum frequency which can be used be computed with 15GHz, and become available also in the field of a microwave band.
[0037] The dielectric which consists of resin generally used as a dielectric substrate 11 on the other hand is specific-inductive-capacity epsilonr. Since it is about two, it cannot use, unless it is more than about 100 GHz, when line breadth is 1mm.
[0038] Moreover, although there is much what has a very small dielectric dissipation factor in such paraelectrics ceramics like an alumina or a silica, all paraelectrics ceramics is not available. In the case of a dielectric-waveguide track, there is almost no loss by the conductor, and most loss at the time of a signal transmission is loss by the dielectric. The loss alpha by the dielectric (dB/m) is expressed as follows.
alpha=27.3xtandelta/[lambda/{1-(lambda/lambdac) 2} 1 / 2]
Inside of a formula, tandelta: Dielectric dissipation factor lambda of a dielectric : Wavelength lambdac in a dielectric : When it applies to the rectangular waveguide (WRJ series) configuration by which cutoff wave length standardization was carried out, it is {1-(lambda/lambdac) 2} 1/2 in an upper type. It is about 0.75.
[0039] Therefore, in order to carry out to below -100 dB/m that is the transmission loss with which practical use can be presented, it is required to choose a dielectric so that the following relation may be materialized.
f is the frequency (GHz) of the RF signal to be used among fxepsilon r 1 / 2 xtandelta<=0.8 type.
[0040] As such a dielectric substrate 11, there are alumina ceramics, alumimium nitride ceramic crystallized glass, etc., for example. While the dielectric substrate 11 by these carries out addition mixing of the suitable organic solvent and solvent for example, for ceramic raw material powder and forms it slurry-like The ceramic green sheet of two or more sheets is obtained by adopting a well-known doctor blade method, the well-known calendering roll method, etc. conventionally, and making this with the shape of a sheet. While performing suitable punching processing for each of these ceramic green sheet after an appropriate time, the laminating of these is carried out. In the case of alumina ceramics, in the case of 1500-1700 degrees C and crystallized glass, it is manufactured by calcinating at the temperature of 1600-1900 degrees C in the case of 850-1000 degrees C and the alumimium nitride ceramics.
[0041] Moreover, the initiative body whorl 12-13, the subconductor layer 15, the line conductor 20 for RFs, and the line conductor 18 for connection of a pair for example, when the dielectric substrate 11 consists of alumina ceramics It prints on a ceramic green sheet so that the transmission line may be completely covered at least by thick film printing using what carried out addition mixing of oxides, an organic solvent, solvents, etc., such as a suitable alumina silica magnesia for metal powder, such as a tungsten, and was made into the shape of a paste. After an appropriate time, It calcinates at about 1600-degree C elevated temperature, and as it becomes the thickness of about 5-15 micrometers, it forms. In addition, in the case of crystallized glass, in the case of the alumimium nitride ceramics, as metal powder, tungsten molybdenum is suitable for copper, gold, and silver. Moreover, generally thickness of the initiative body whorl 12-13 and the subconductor layer 15 is set to about 5-50 micrometers.
[0042] moreover, the penetration for side attachment walls -- a conductor -- a group 14 and the penetration for connection -- the penetration which constitutes a conductor 17 -- a conductor -- for example, a beer hall -- a conductor and a through hole -- what is necessary is just to form with a conductor etc. The cross-section configuration may be polygons, such as a rectangle besides a round shape with easy manufacture, and a rhombus. these penetration -- the metal paste same to the through tube which pierced the conductor for example, to the ceramic green sheet, processed, and was produced as initiative body whorl 12.13 grade -- embedding -- after an appropriate time and dielectric substrate 11 grade -- simultaneously, it calcinates and forms. in addition, penetration -- a conductor -- diameters 50-300 mum is suitable.
[0043]
[Example] Next, the example of the connection structure of the dielectric-waveguide track of this invention and the line conductor for RFs is explained.

[0044] Drawing 2 is the perspective view showing the outline configuration of an example of the gestalt of operation of the connection structure of the dielectric-waveguide track of this invention, and the line conductor for RFs, the same sign is given to the same part as drawing 1 , and the dielectric substrate 11 has omitted the display. moreover, the penetration for side attachment walls for forming a side attachment wall, in order to make an understanding easy -- a conductor -- a side attachment wall equivalent about a group 14 and the subconductor layer 15 expresses, and the dielectric-waveguide track 16 is expressed as the profile.
[0045] In the case of this example, it is specific-inductive-capacity epsilonr to a dielectric substrate. 4.8 Track width of face of the microstrip line as 1.5 mmx0.6 mm and a line conductor 20 for RFs was set to 0.267 mm for the size of the cross section of the dielectric-waveguide track 16 using the ceramic ingredient. Moreover, the dielectric-waveguide track 16 carried out the four-sheet laminating of the dielectric substrate whose thickness is 0.15mm, and constituted it.
[0046] In this example, the upper part of a microstrip line is made into air, and 0.279 mm insertion is carried out at the opening edge of the edge dielectric-waveguide track 16 of that line conductor 20. a converter 19 -- 0.15mm spacing -- the line conductor 18 for connection -- two-layer formation -- carrying out -- between the edge of the edges of each line conductor 18, and the line conductor 20 for RFs, and the initiative body whorls 12 of the dielectric-waveguide track 16 -- the penetration for connection -- it connected electrically with the conductor 17. At this time, each set the line conductor 18 for connection of the 1st layer and a two-layer eye to width-of-face 0.267 mm and die-length 0.279 mm. moreover, the penetration for connection -- the conductor 17 was made into diameter 0.1 mm and die length of 0.15mm. the edge of the line conductor 20 for RFs inserted in the opening edge of the dielectric-waveguide track 16 by this -- two or more penetration for connection -- pass a conductor 17 and two or more line conductors 18 for connection -- it connects with the initiative body whorl 12 of the dielectric-waveguide track 16 electrically.
[0047] And about the example of a comparison which did not prepare this example and transducer 19 (penetration for connection a conductor 17 and the line conductor 18 for connection), the reflection coefficient S11 of connection structure was measured with the network analyzer, and it asked for it. The result is shown in drawing 3 .
[0048] Drawing 3 is the diagram showing the frequency characteristics of the reflection coefficient S11 in connection structure with the line conductor for RFs of a dielectric-waveguide track, an axis of abscissa expresses a frequency (unit: GHz), an axis of ordinate expresses a reflection coefficient S11 (unit: dB), among the characteristic curves which show the frequency characteristics of a reflection coefficient S11, A shows the property of the example of a comparison and B shows the property of the example of this invention.
[0049] according to [the result of the connection structure of this invention] B to the reflection coefficient S11 having consisted of a result of drawing 3 only by about -6dB in A as a result of the example of a comparison without a transducer -- the penetration for connection -- by preparing the transducer which consists of a conductor and the line conductor for connection shows that the good property of -20dB or less was acquired for the reflection coefficient S11. This shows that matching of the characteristic impedance of a dielectric-waveguide track and the line conductor for high frequency is performed by the transducer (penetration for connection a conductor and the line conductor for connection) concerning the connection structure of this invention.
[0050]
[Effect of the Invention] According to the connection structure of the dielectric-waveguide track of this invention, and the line conductor for RFs, as explained in full detail above The line conductor for connection which inserted the edge of the line conductor for RFs in the opening edge of a dielectric-waveguide track, and was arranged in parallel in the same transmission direction as the line conductor for RFs in the edge and one of the initiative body whorl of a dielectric-waveguide track of these, the penetration for connection arranged in the edge of this line conductor for connection by intersecting perpendicularly -- from having connected electrically so that the shape of a stairway might be accomplished with a conductor A miniaturization can be attained by the ability making thickness of a connection into thin structure, and, moreover, the reflection loss of the RF signal in a connection can acquire the small excellent transparency property. Furthermore, even if it is the case where the characteristic impedances of a dielectric-waveguide track and the line conductor for RFs differ, matching of a characteristic impedance can be taken and it can be made to connect in a good property.
[0051] And since the connection structure of the dielectric-waveguide track of this invention and the line conductor for RFs is easily producible with sheet lamination techniques, such as a green sheet laminated layers method, productivity can manufacture it cheaply highly.

[0052] According to this invention, by the above, the connection structure of the dielectric-waveguide track and the line conductor for RFs which can connect line conductors for RFs, such as a dielectric-waveguide track of a laminating mold, and other microstrip lines, the strip line, a RF track, in a good property even if both characteristic impedances differ was able to be offered.

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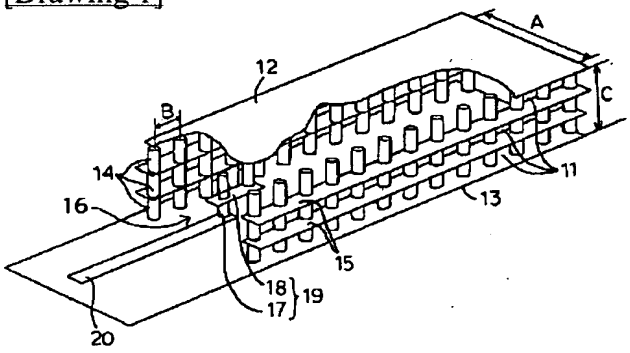
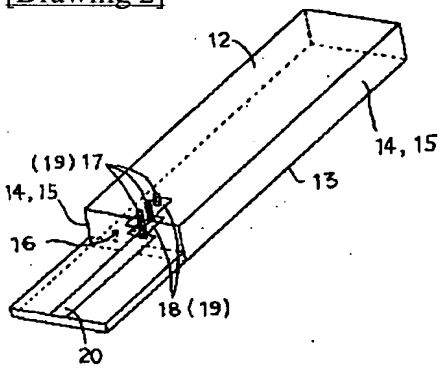
DRAWINGS

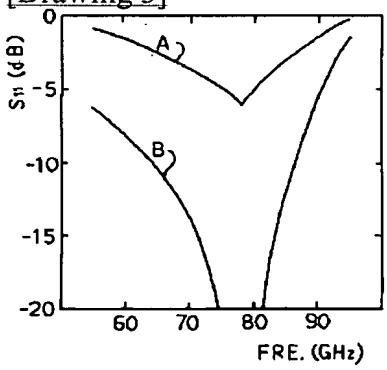
[Drawing 1]



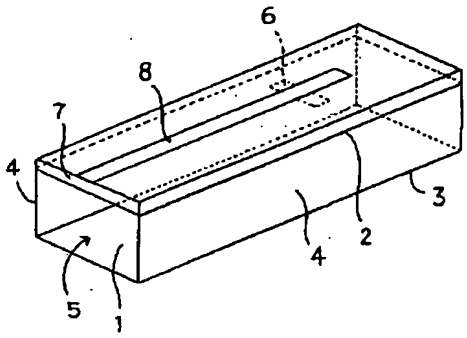
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]